

# Technology

## Air Quality and STFC technology

The success of STFC's research depends on the delivery of large-scale science facilities<sup>1</sup>, instruments, international research partnerships and space missions<sup>2</sup> that rely, in turn, on development of leading-edge technologies and expertise. STFC's needs often go far beyond the state of the art, so off-the-shelf solutions can rarely satisfy. It would have been impossible for the Nobel Prize winning researchers to observe the gravitational waves<sup>3</sup> arising from the collision of two black holes without the novel technologies developed by STFC and our partners as an integral part of our research.

STFC has become a world-renowned supplier of leading research instrumentation, engineering and facilities, and has built an outstanding track record in this area. This brings wider advantages to the UK by providing a wealth of emerging, disruptive technologies and expertise applicable to commercial and public-policy challenges.

For example, STFC develops technology for harsh space and planetary environments. Instruments must be compact, lightweight,

low-power, robust and autonomous whilst delivering high performance. These are attributes that are well suited to field deployment on Earth. These expertise and technologies have impacts far beyond the space sector, with spinout companies commercialising technology for applications as diverse as breath analysis for early diagnosis in healthcare and industrial pollution monitoring.

1. <https://stfc.ukri.org/research/our-science-facilities/>
2. <https://www.ralspace.stfc.ac.uk/Pages/Missions.aspx>, <https://www.technologysi.stfc.ac.uk/Pages/Projects-at-UKATC.aspx>
3. <https://stfc.ukri.org/research/gravitational-waves/>
4. <https://www.ralspace.stfc.ac.uk/Pages/Spectroscopy.aspx>
5. LDS, <https://www.ralspace.stfc.ac.uk/Pages/Long-open-path-laser-dispersion-sensing.aspx>



### Case study – A new technique to observe atmospheric trace gases

Developed by STFC's RAL Space Spectroscopy Group<sup>4</sup>, Laser Dispersion Spectroscopy<sup>5</sup> is a new open path gas sensing technique that applies a novel approach to infrared tuneable diode laser spectroscopy. Most traditional techniques depend on measuring transmitted intensity to derive gas concentration. This approach is not always well suited to real-world environments where the detected intensity of the transmitted light can fluctuate due to scattering from dust and other atmospheric effects.

The LDS technique derives concentration from phase changes in the detected light caused by molecules in the optical path. This makes measurements highly immune to intensity fluctuations caused by environmental factors. Hence LDS enables precise, real-time measurements of trace gas molecules in demanding environments. Furthermore, compared to absorption-based techniques, LDS can measure gas concentrations across a very wide dynamic range in a single measurement, typically about five to six orders of magnitude. This means concentrations ranging from parts per billion to sub-percent levels can be measured without the requirement for dilution or a change in optical configuration.

In a long open-path multi-direction configuration, using retroreflector arrays and an anemometer, the LDS technique is capable of measuring gas concentrations over large areas, and can locate and quantify emission sources.

The technique has been successfully used to measure diffuse greenhouse gas emissions, such as methane, and has potential to observe species relevant to air quality. More information about LDS and the methane measurements are available here doi: 10.1029/2019GL086725.

Other areas of expertise within the STFC community include: precision fabrication; micro and nanotechnology; sensor modelling and sensor technology development; and rapid prototyping. STFC also provides environmental test facilities and field test sites for instruments.



#### Relevant STFC departments

**RAL Space** - [www.ralspace.stfc.ac.uk](http://www.ralspace.stfc.ac.uk)

**Technology Department** - [www.technologysi.stfc.ac.uk](http://www.technologysi.stfc.ac.uk)

**UK Astronomy Technology Centre** - [www.stfc.ukri.org/about-us/where-we-work/royal-observatory-edinburgh/uk-astronomy-technology-centre/](http://www.stfc.ukri.org/about-us/where-we-work/royal-observatory-edinburgh/uk-astronomy-technology-centre/)